Lithological controls on fluvial response to active faulting, Gediz Graben

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Study Outline

In order to consider the impact of external factors (e.g. active faulting) on bedrock rivers and the surrounding landscape, landscape evolution models were developed. Rivers are important drivers of erosion in the models, therefore it is vital to be able to parameterise fluvial incision effectively. Therefore, it is important to be able to predict how channel slope, river geometry, discharge and factors such as lithology and climate, control energy expenditure and modulate bedrock erosion in time and space. The detachment-limited incision model, usually used to model rivers incising into bedrock in mountainous regions assumes in its simplest form that fluvial incision is proportional to stream power, which in turn is dependent upon the river discharge and geometry. It is generally assumed that many bedrock rivers can be adequately described by a stream power model. This study addresses methods of predicting channel widths and stream power through the analysis of the hydraulic geometry, stream powers and substrate lithologies of six rivers responding to an increased rate of normal faulting, due to fault linkage, in the Gediz Graben (western Turkey).

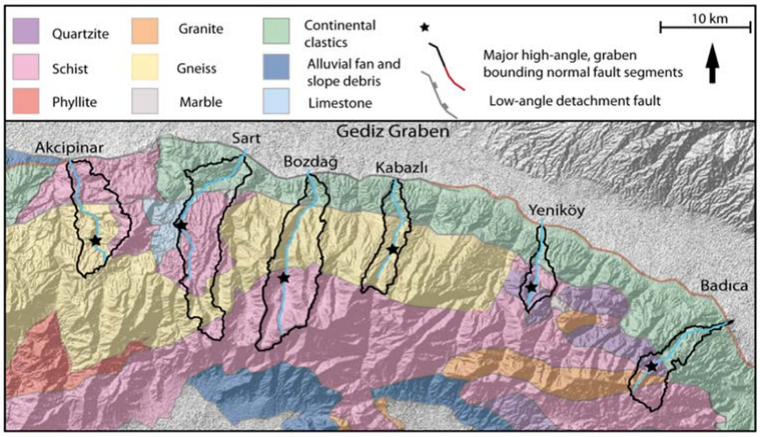

Figure 1: simplified geological map with the 6 catchments (black). Black stars are knickpoints initiated by enhanced throw rate on the graben bounding normal fault.

Methods

A BSG postgraduate research grant funded four weeks of field work where six rivers were followed from their source to where they cross the active normal faults that bound the mountain range. A number of measurements were taken along the channels at ~300m intervals including channel width, depth, local slope, lithology with details of any jointing and fractures present and percentage of the channel mantled in sediment. A Schmidt hammer was used to measure the rebound strength of the rock in each location. Additional information such as drainage areas and river length were extracted from DEMs using Arc Map and RiverTools software. The width of the channels and stream powers along the channel were predicted using accepted hydraulic scaling methods and compared to those calculated with field measurements.

Figure 2: Field photographs of the Kabazlı River showing significant incision above the knickpoint.

Findings

Preliminary results show that the use of traditional hydraulic scaling relationships to predict the widths of the Gediz Graben rivers is problematic. Two models of width prediction were tested, which each give slope a varying importance in determining channel width. These methods fail to predict river widths in the Gediz Rivers, and also subsequently lead to inaccurate modelling of the stream powers when compared to those calculated from field measurements. This highlights that care must be taken when predicting stream powers using widths produced by hydraulic scaling relationships. The failure to predict width propagates directly into estimates of river erosivity and the results of the field study show that lithology might be having a larger impact on stream powers than is accounted for in the models.